

Application Serial No. 10/750,347

Amendment Dated: June 8, 2007

Response to First Office Action of March 8, 2007

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Amendment to the Claims:

This listing of claims will replace all prior versions and listings of claims in the application.

Listing of Claims:

Claim 1. (currently amended): A freeze tolerant fuel cell power plant for generating an electrical current from hydrogen containing reducing fluid fuel and oxygen containing oxidant reactant streams, the plant comprising:

- 5       a.    at least one fuel cell (12) including a coolant inlet (14) and a coolant outlet (16) for directing a water immiscible fluid and a water ~~coolant~~ component to flow through the fuel cell (12);
- 10       b.    a coolant loop (18) including a freeze tolerant accumulator means (22) secured in fluid communication with the fuel cell coolant outlet (16) for storing and separating the water immiscible fluid and the water ~~coolant~~ component, a direct contact heat exchanger (56) secured in fluid communication with the
- 15       accumulator means (22) and the fuel cell coolant inlet (14), and a coolant circulating means (21) secured in fluid communication with a coolant passage (20) of the coolant loop (18) for circulating the water immiscible fluid and the water ~~coolant~~ component through the
- 20       coolant loop (18);

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- 25           c.    a radiator loop (84) including a radiator (86) secured  
              in fluid communication between a water immiscible  
              fluid discharge (91) and water immiscible fluid inlet  
              (90) of the direct contact heat exchanger (56) that  
              removes heat from the water immiscible fluid passing  
              through the radiator (86), and a radiator pump (92)  
              secured to the radiator loop (84) for circulating the  
              water immiscible fluid through the radiator (86) and  
              direct contact heat exchanger (56); and,
- 30           d.    a direct contact heat exchanger by-pass system means  
              (200) for directing flow of ~~coolant~~ the water  
              component from the coolant loop (18) directly through  
              the radiator (86) and back to the coolant loop (18)  
              by-passing the direct contact heat exchanger (56).

5    Claim 2 (currently amended): The freeze tolerant fuel cell  
power plant (10) of claim 1, wherein the direct contact heat  
exchanger by-pass system means (200) comprises by-pass valve  
means for directing the ~~coolant~~ water component to flow from the  
coolant loop (18) through a by-pass feed line (201) to the  
radiator (86) and from the radiator (86) through a by-pass  
return line (202) back to the coolant loop (18) by-passing the  
direct contact heat exchanger (56).

Claim 3 (currently amended): The freeze tolerant fuel cell  
power plant (10) of claim 2, wherein the direct contact heat  
exchanger by-pass system means (200) further comprises water  
immiscible fluid isolation valve means for restricting flow of

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5 the water immiscible fluid from the direct contact heat  
exchanger (56) and the radiator loop (84) into the coolant loop  
(18) whenever the by-pass valve means are directing flow of the  
~~coolant~~ water component directly from the coolant loop (18) to  
the radiator (86) and back to the coolant loop (18) by-passing  
10 the direct contact heat exchanger (56).

Claim 4 (currently amended): The freeze tolerant fuel cell  
power plant (10) of claim 2, wherein the by-pass valve means  
comprises a coolant loop by-pass feed valve (204) for  
selectively directing flow of the ~~coolant~~ water component from  
5 the coolant loop (18) into the by-pass feed line (201), a direct  
contact heat exchanger feed valve (54) and direct contact heat  
exchanger by-pass valve (83) for selectively prohibiting flow of  
the ~~coolant~~ water component into the direct contact heat  
exchanger (56), and a radiator loop by-pass valve (206) for  
10 selectively directing the ~~coolant~~ water component discharged out  
of the radiator (86) into the by-pass return line (202).

Claim 5 (currently amended): The freeze tolerant fuel cell  
power plant (10) of claim 3, wherein the water immiscible fluid  
isolation valve means comprises a direct contact heat exchanger  
discharge valve (208) secured in fluid communication with an  
5 outlet of the direct contact heat exchanger (56) for selectively  
prohibiting flow of the ~~coolant~~ water component out of the heat  
exchanger (56), and a radiator inlet valve (210) secured in  
fluid communication between the by-pass feed line (201), the  
direct contact heat exchanger (56) and the radiator (86) for

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- 10 selectively directing flow from either the by-pass feed line (201) or the heat exchanger (56) into the radiator (86).

Claim 6 (original): The freeze tolerant fuel cell power plant (10) of claim 1, wherein the water immiscible fluid is selected from the group consisting of silicones, silicone copolymers, substituted silicones, siloxanes, polysiloxanes, substituted  
5 siloxanes or polysiloxanes and mixtures thereof.

Claim 7 (original): The freeze tolerant fuel cell power plant (10) of claim 1, wherein the water immiscible fluid is selected from the group consisting of perfluorocarbons, hydrofluoroethers and mixtures thereof.

Claim 8 (original): The freeze tolerant fuel cell power plant (10) of claim 1, wherein the water immiscible fluid is selected from the group consisting of alkanes, alkenes, alkynes having six or more carbon atoms and mixtures thereof.

Claim 9 (original): The freeze tolerant fuel cell power plant (10) of claim 1, wherein the water immiscible fluid has a freezing temperature equal to or less than minus twenty degrees Celsius, has a surface tension of less than or equal to 35  
5 dynes/cm, and has a solubility in water of less than 0.1 percent.

Claim 10 (original): The freeze tolerant fuel cell power plant (10) of claim 1, wherein the water immiscible fluid has a

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freezing temperature equal to or less than minus twenty degrees Celsius, has a surface tension of less than or equal to 20 dynes/cm, and has a solubility in water of less than 0.1 percent.

11. (currently amended): A method of operating a freeze tolerant fuel cell power plant (10), the power plant (10) including at least one fuel cell (12) having a coolant inlet (14) and a coolant outlet (16) for directing a water immiscible fluid and a water ~~coolant~~ component to flow through the fuel cell (12), a coolant loop (18) including a freeze tolerant accumulator (22) secured in fluid communication with the fuel cell coolant outlet (16) for storing and separating the water immiscible fluid and the water ~~coolant~~ component, and a coolant pump (21) secured in fluid communication with a coolant passage (20) of the coolant loop (18) for circulating ~~coolant~~ the water component and water immiscible fluid through the coolant loop (18), the method comprising the steps of:

- a. securing a direct contact heat exchanger (56) in fluid communication with the accumulator (22) and the fuel cell coolant inlet (14);
- b. providing a radiator loop (84) including a radiator (86) secured in fluid communication between a water immiscible fluid discharge (91) and water immiscible fluid inlet (90) of the direct contact heat exchanger (56) that removes heat from the water immiscible fluid passing through the radiator (86), a radiator pump (92) secured to the radiator loop (84) for circulating

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- 25 the water immiscible fluid through the radiator (86)  
and direct contact heat exchanger (56); and,  
c. selectively directing flow of the ~~coolant~~ water  
component from the coolant loop (18) directly through  
the radiator (86) and back to the coolant loop (18)  
by-passing the direct contact heat exchanger (56).

Claim 12 (currently amended): The method of claim 11, comprising  
the further steps of restricting flow of the water immiscible  
fluid from the direct contact heat exchanger (56) and the  
radiator loop (84) into the coolant loop (18) whenever the  
5 ~~coolant~~ water component is directed to flow directly from the  
coolant loop (18) to the radiator (86) and back to the coolant  
loop (18) by-passing the direct contact heat exchanger (56).

Claim 13 (currently amended): The method of claim 11,  
comprising the further step of directing flow of the ~~coolant~~  
water component from the coolant loop (18) through the radiator  
(86) and back to the coolant loop (18) by-passing the direct  
5 contact heat exchanger (56) whenever an ambient temperature is  
greater than thirty degrees Celsius.

Claim 14 (new): The method of claim 11, comprising the further  
step of turning off the radiator pump (92) during the step of  
selectively directing flow of the water component from the  
5 coolant loop (18) directly through the radiator (86).

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Claim 15 (new): A freeze tolerant fuel cell power plant for generating an electrical current from hydrogen containing reducing fluid fuel and oxygen containing oxidant reactant streams, the plant comprising:

- 5           a. at least one fuel cell (12) including a coolant inlet (14) and a coolant outlet (16) for directing a water immiscible fluid and a water component to flow through the fuel cell (12);
- 10           b. a coolant loop (18) including a freeze tolerant accumulator means (22) secured in fluid communication with the fuel cell coolant outlet (16) for storing and separating the water immiscible fluid and the water component, a direct contact heat exchanger (56) secured in fluid communication with the accumulator means (22) and the fuel cell coolant inlet (14), and a
- 15           coolant circulating means (21) secured in fluid communication with a coolant passage (20) of the coolant loop (18) for circulating the water immiscible fluid and the water component through the coolant loop
- 20           (18);
- 25           c. a radiator loop (84) including a radiator (86) secured in fluid communication between a water immiscible fluid discharge (91) and water immiscible fluid inlet (90) of the direct contact heat exchanger (56) that removes heat from the water immiscible fluid passing through the radiator (86), and a radiator pump (92) secured to the radiator loop (84) for circulating the

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water immiscible fluid through the radiator (86) and direct contact heat exchanger (56); and,

30 d. a direct contact heat exchanger by-pass system means (200) for directing flow of the water component from the coolant loop (18) through the radiator (86) and back to the coolant loop (18) by-passing the direct contact heat exchanger (56), the direct contact heat

35 exchanger by-pass system means (200) comprising a by-pass valve means for directing the water component to flow from the coolant loop (18) through a by-pass feed line (201) to the radiator (86) and from the radiator

40 (86) through a by-pass return line (202) back to the coolant loop (18) by-passing the direct contact heat exchanger (56).

Claim 16 (new): The freeze tolerant fuel cell power plant (10) of claim 15, wherein the direct contact heat exchanger by-pass system means (200) further comprises water immiscible fluid isolation valve means for restricting flow of the water

5 immiscible fluid from the direct contact heat exchanger (56) and the radiator loop (84) into the coolant loop (18) whenever the by-pass valve means are directing flow of the water component directly from the coolant loop (18) to the radiator (86) and back to the coolant loop (18) by-passing the direct contact heat

10 exchanger (56).

Claim 17 (new): The freeze tolerant fuel cell power plant (10) of claim 15, wherein the by-pass valve means comprises a



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coolant loop by-pass feed valve (204) for selectively directing  
flow of the water component from the coolant loop (18) into the  
5 by-pass feed line (201), a direct contact heat exchanger feed  
valve (54) and direct contact heat exchanger by-pass valve (83)  
for selectively prohibiting flow of the water component into the  
direct contact heat exchanger (56), and a radiator loop by-pass  
valve (206) for selectively directing the water component  
10 discharged out of the radiator (86) into the by-pass return line  
(202).

Claim 18 (new): The freeze tolerant fuel cell power plant  
(10) of claim 16, wherein the water immiscible fluid isolation  
valve means comprises a direct contact heat exchanger discharge  
valve (208) secured in fluid communication with an outlet of the  
5 direct contact heat exchanger (56) for selectively prohibiting  
flow of the water component out of the heat exchanger (56), and  
a radiator inlet valve (210) secured in fluid communication  
between the by-pass feed line (201), the direct contact heat  
exchanger (56) and the radiator (86) for selectively directing  
10 flow from either the by-pass feed line (201) or the heat  
exchanger (56) into the radiator (86).